

Strategic Roadmap #9

Earth System Change and
Consequences for Life on Earth and
Beyond

Sample Scenarios

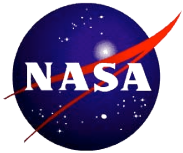


Background



- The product of each roadmap team is to be a report structured as follows:
 1. Introduction
 2. Agency objective statement
 3. National Policy Framework
 4. External Constituencies
 5. Overview of Specific Objectives and Desired Outcomes
 6. The Roadmap
 7. Required Capabilities
 8. Unique Education and Outreach Opportunities
 9. Inter-roadmap Dependencies
 10. Conclusion

The intent of this presentation is to provide a framework for the committee to populate the content of the sections in red



Assumptions



- “The EOS Era is over - we’ve completed the 15-year plan and now we have to plan the next 25-30 years” - Ghassem Asrar at the Fall AGU 2004
- Decadal Survey gathering community input on the future of Earth Science and Applications from Space - opportunity to provide input
- Al Diaz at Fall AGU - “Strategic roadmaps will be traceable to the 3 Presidential Directives on:
 - Climate Change
 - The US Integrated Earth Observation System (IEOS)
 - The Space Exploration Vision”
- Another presidential directive, the “Oceans Action Plan” calls for a U.S. Integrated Ocean Observing System to be a major element of an international Global Ocean Observing System (GOOS)
- The IEOS and the US component of GOOS are to be developed within the framework of the international Global Earth Observing System of Systems (GEOSS)
- As NPP and NPOESS platforms are launched, many environmental/climate measurements currently provided by NASA will transition to NOAA
- “NASA Earth Science needs an ‘identity’ that can capture the public’s imagination” - Ed Weiler, GSFC
- NASA Strategic Roadmapping under way - roadmaps (including this one) will be integrated at the agency level
- NASA wants a flexible Earth Science program, with a clear prioritization scheme and decision points

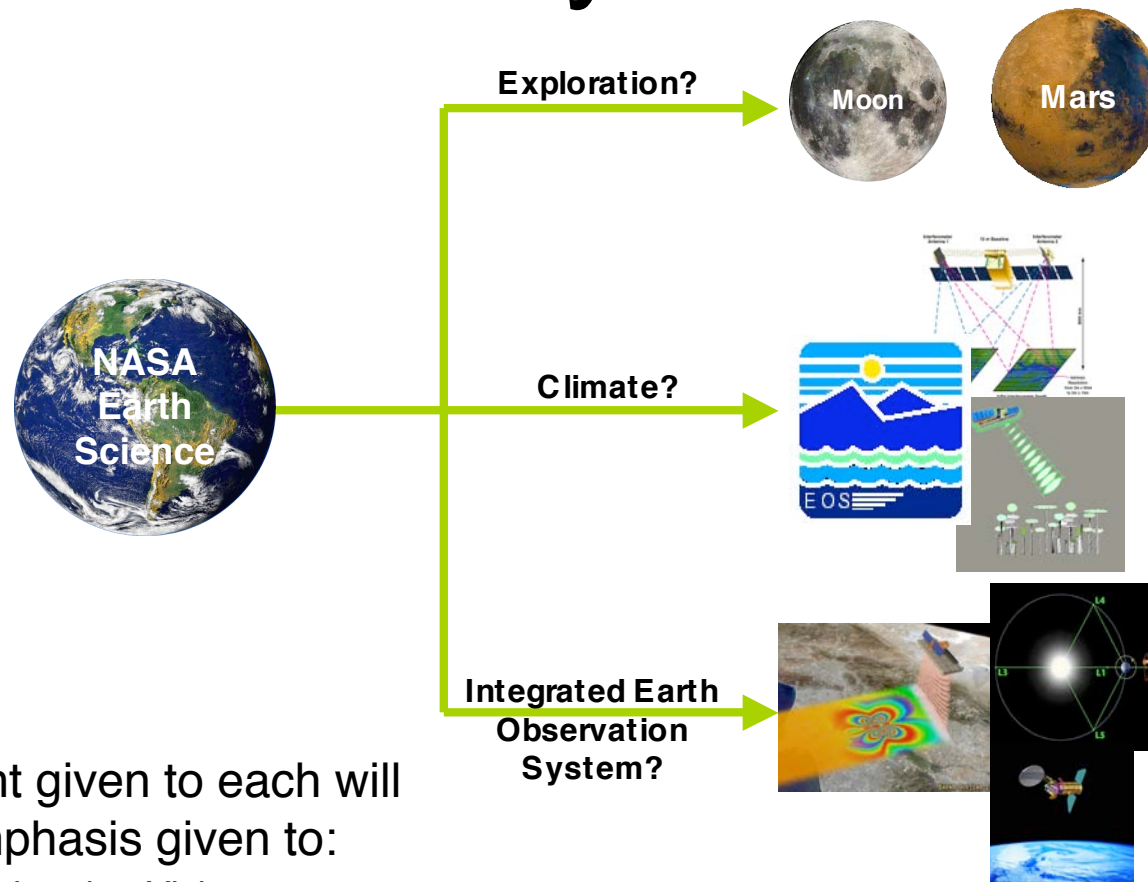


Overview of Specific Objectives and Desired Outcomes

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NASA Earth Science - Pathways Forward



Relative weight given to each will depend on emphasis given to:

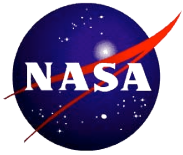
- The Space Exploration Vision
- Climate Change
- The US Integrated Earth Observation System



Roadmaps 9 and 10 - Goals

(9) Advance scientific knowledge of the Earth System through space-based observations, assimilation of new observations, and development and deployment of enabling technologies, systems and capabilities, including those with the potential to improve future operational systems.

(10) Explore the Sun–Earth system to understand the Sun and its effects on Earth, the solar system, and the space environmental conditions that will be experienced by human explorers, and demonstrate technologies that can improve future operational Earth observation systems.

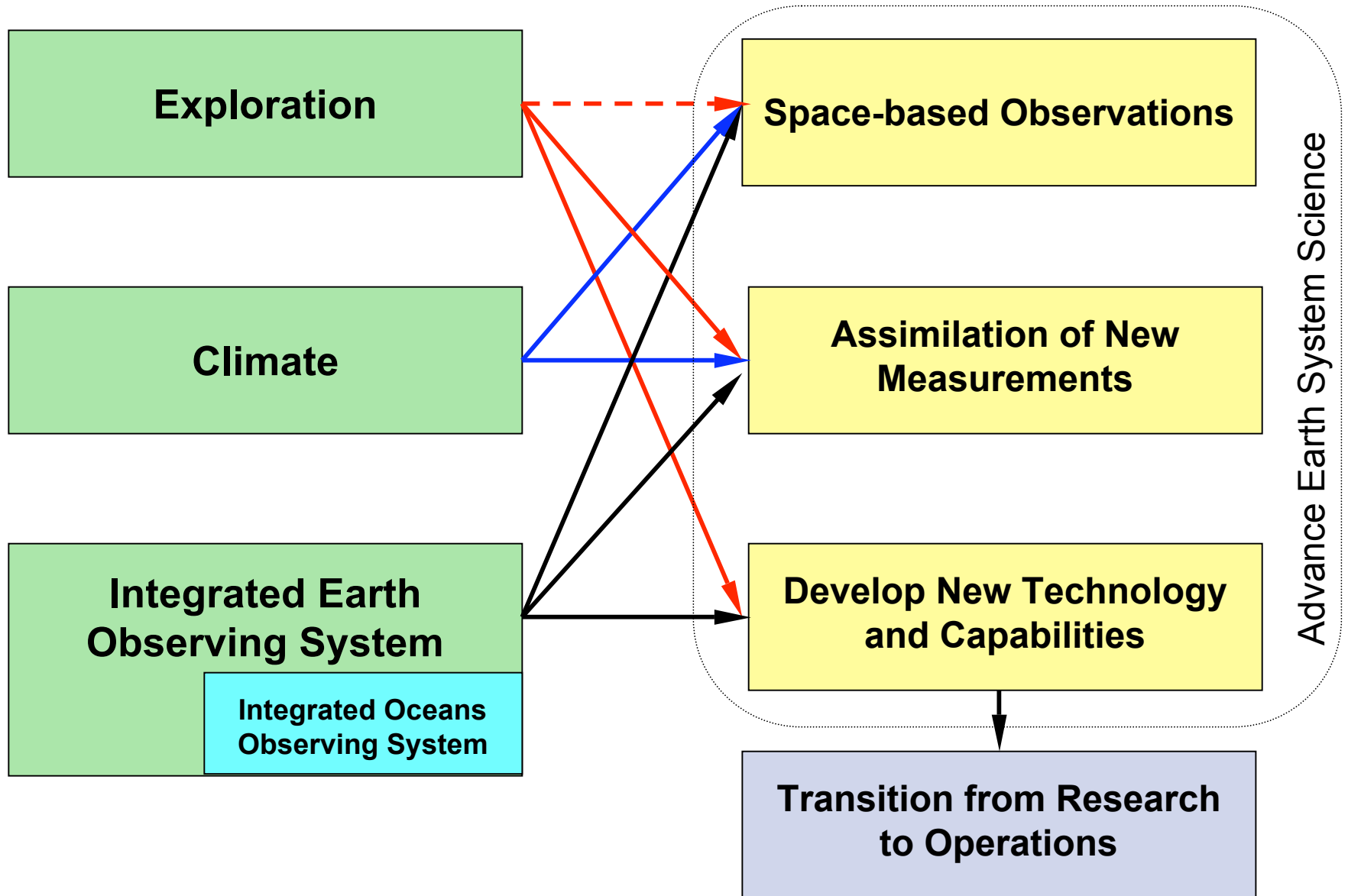


Roadmap #9 - Goal Breakdown

- Conduct a program of research and technology to advance scientific knowledge of the Earth System through:
 1. *Space-based observations*
 2. *Assimilation of new measurements*
 3. *Development and deployment of new technologies and capabilities, including those with the potential to improve future operational systems*

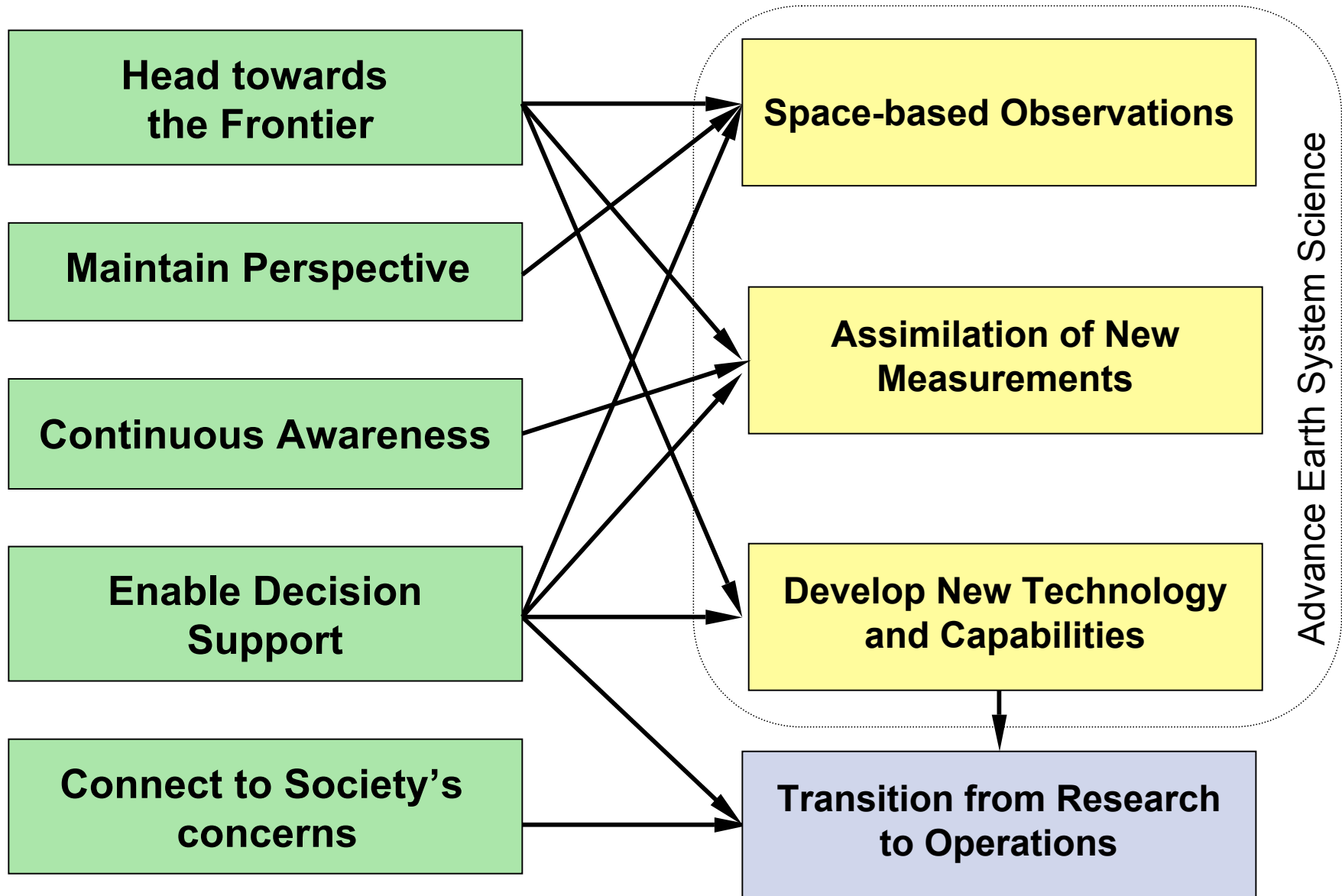


Traceability to Presidential Directives





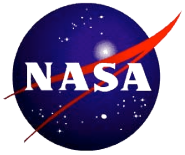
Traceability to Roadmap Committee Goals





Desired Outcomes

- What are the Figures of Merit for a program which can achieve these goals?
 1. Space-based observations - *# of new measurements, # of discoveries, accuracy of predictions, timescales covered vs. those required, resources allocated?*
 2. Assimilate new observations - *# of new measurements assimilated, degree of assimilation, resources allocated?*
 3. Develop and deploy new technologies and capabilities, including those with the potential to improve future operational systems - *priority given to high consequence/high likelihood risks, # of successful transfers in capability from research to operations, resources allocated?*

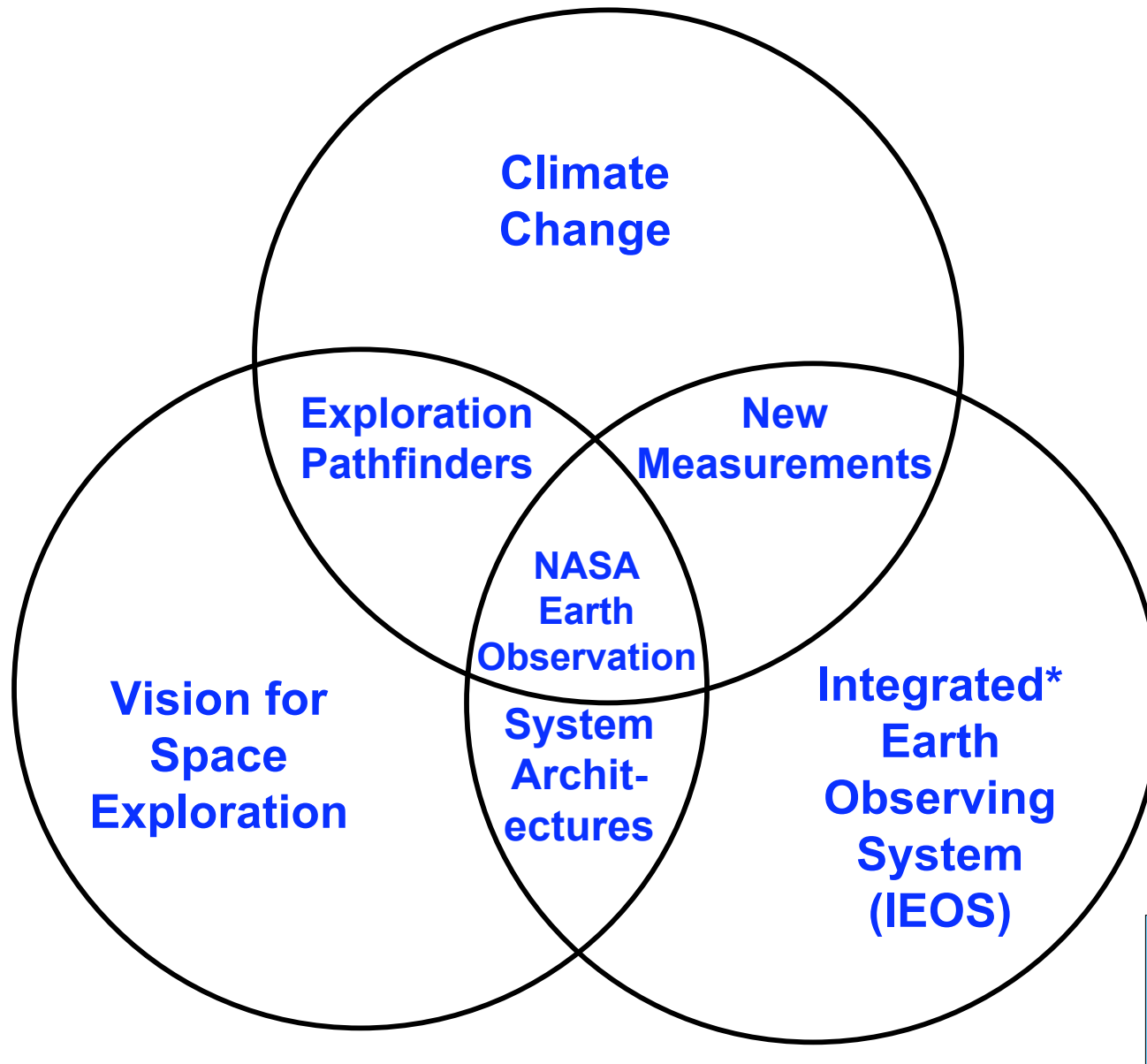


Inter-roadmap Dependencies

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Roadmap #9 Interfaces



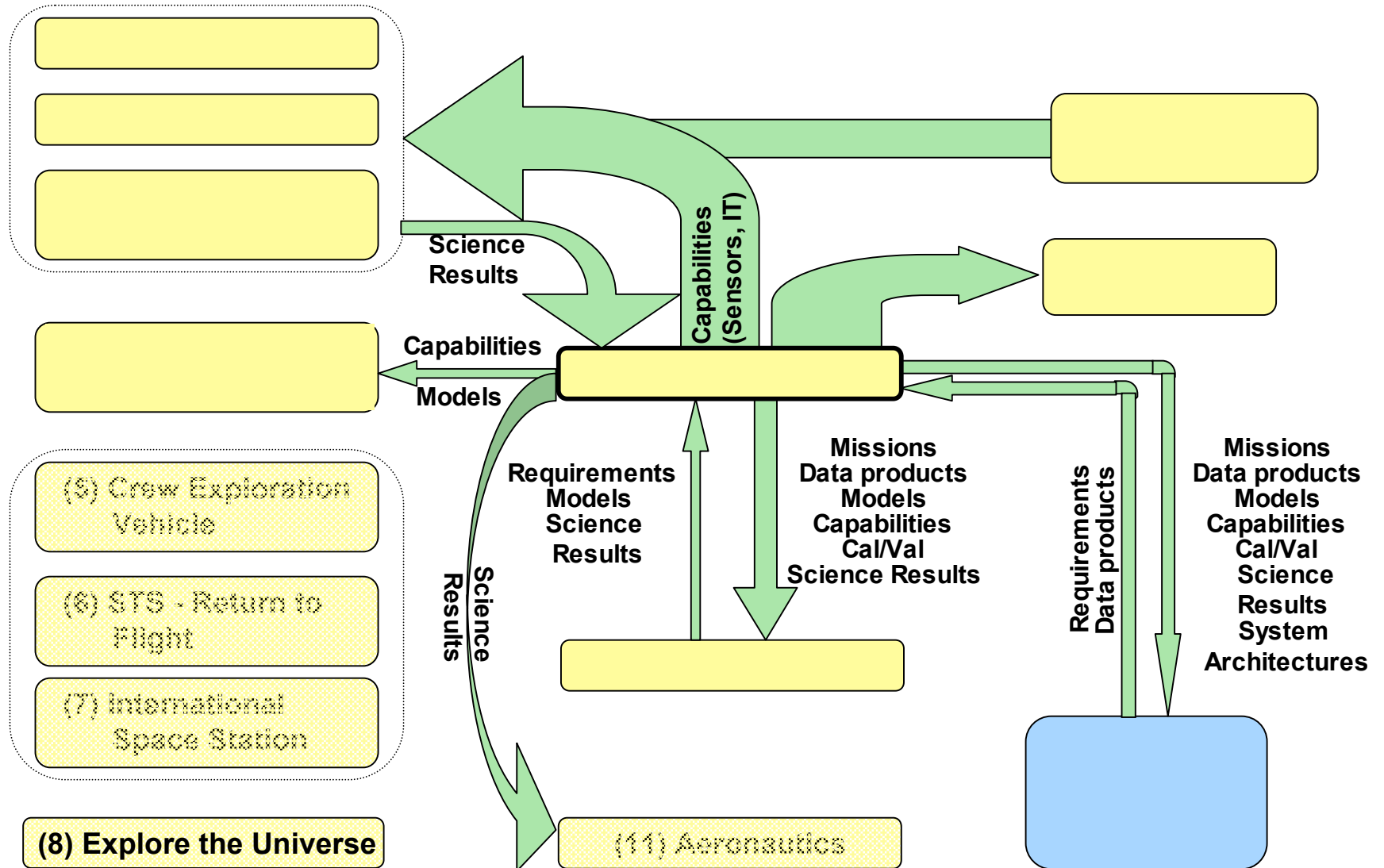


Roadmap #9 - Products

- List of outputs from the program:
 1. Missions
 2. Data Products
 3. Models
 4. Science Results
 5. Calibration/Validation (Cal/Val)
 6. Capabilities (Sensors and IT)
 7. System Architectures

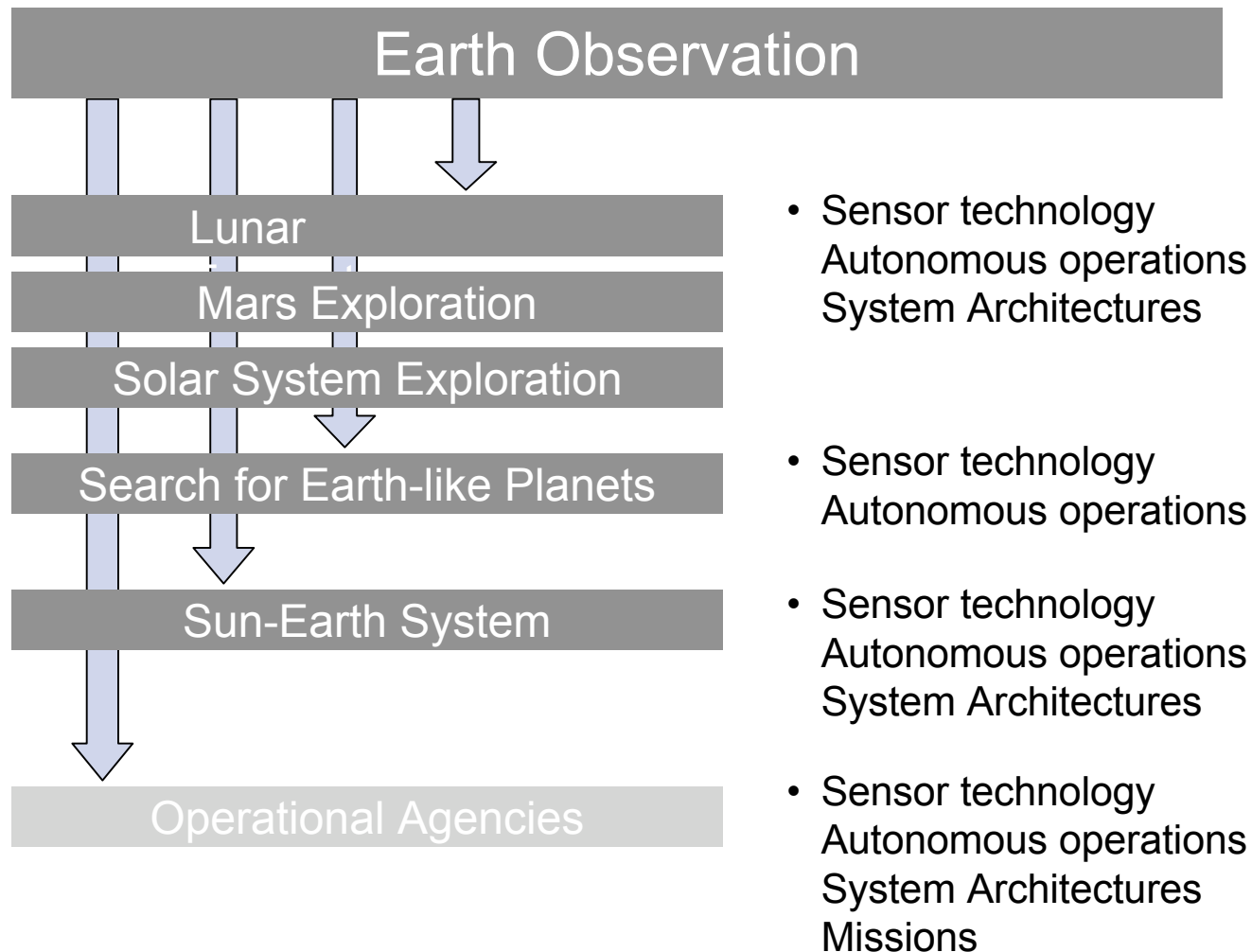


Roadmap #9 Interfaces





Major System Relationships: Earth Observation

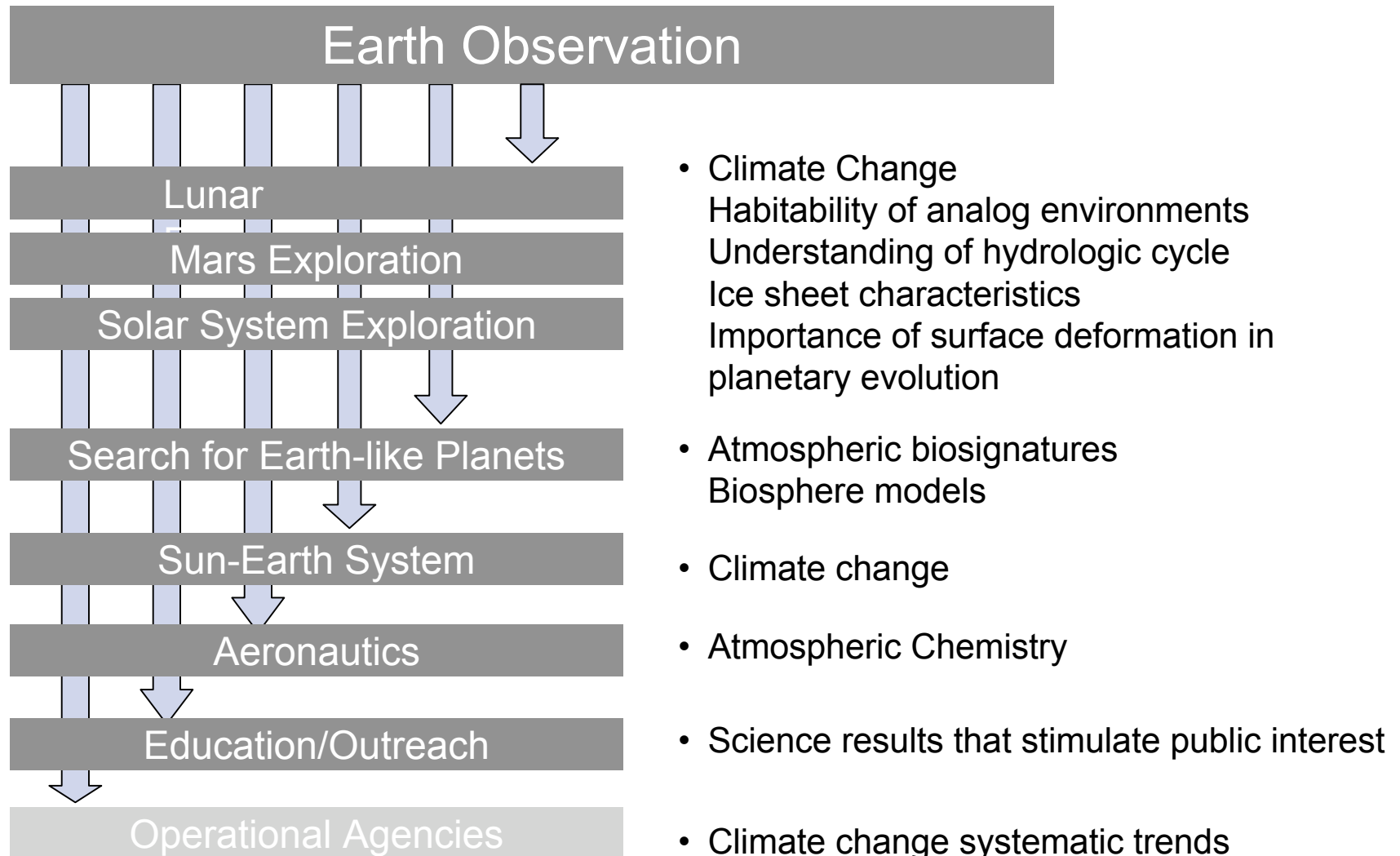


Note: there are currently no arrows going into Earth Observation

Goal: Identify capabilities developed by Earth Observation that enable other agency objectives



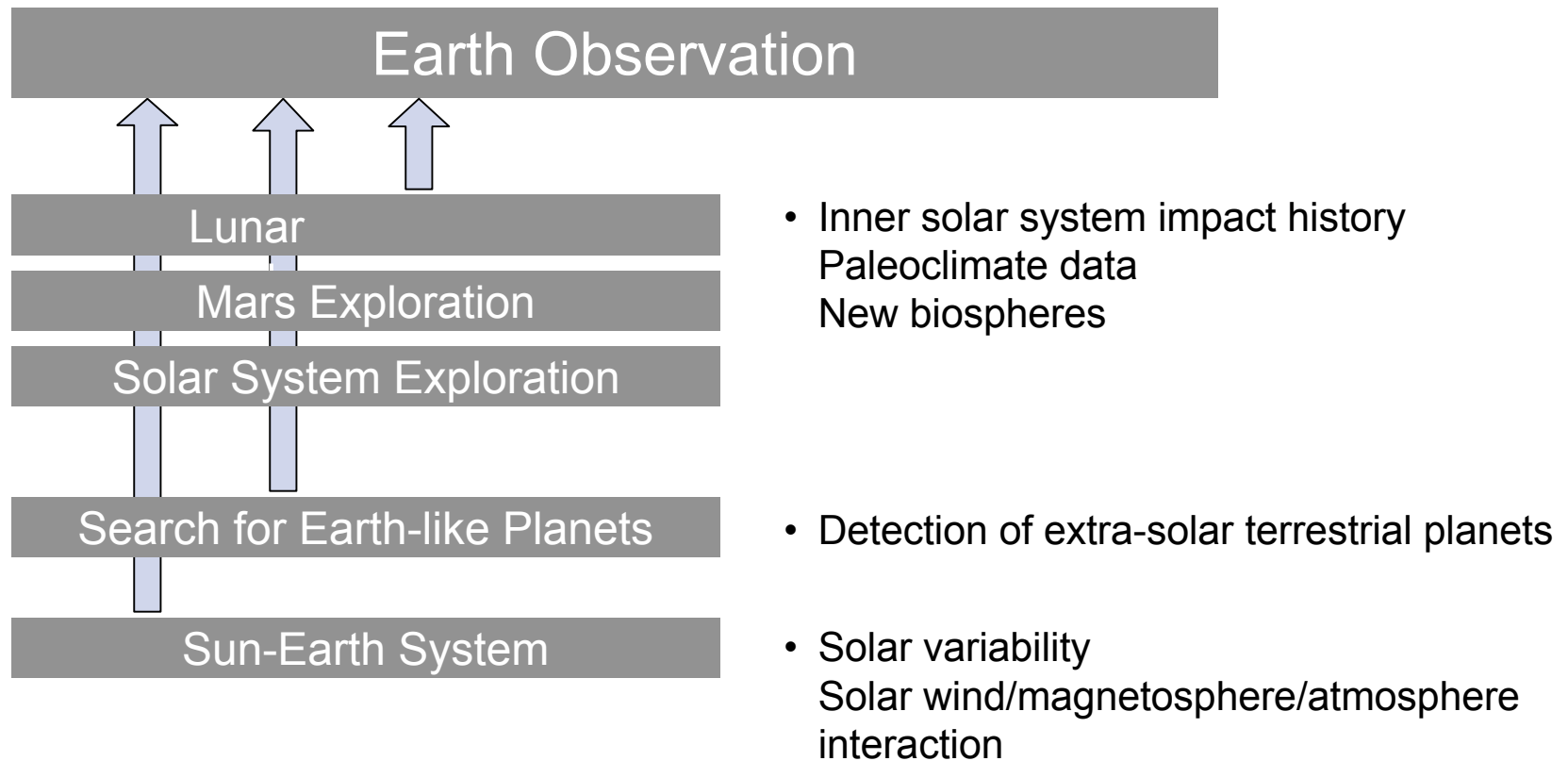
Major Science Relationships: Earth Observation



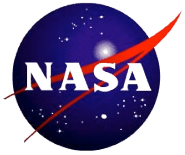
Goal: Identify investigations or discoveries which may benefit from Earth Observation objectives



Major Science Relationships: Earth Observation

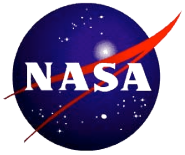


Goal: Identify investigations or discoveries which may inform Earth Observation objectives



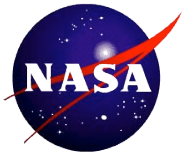
The Roadmap

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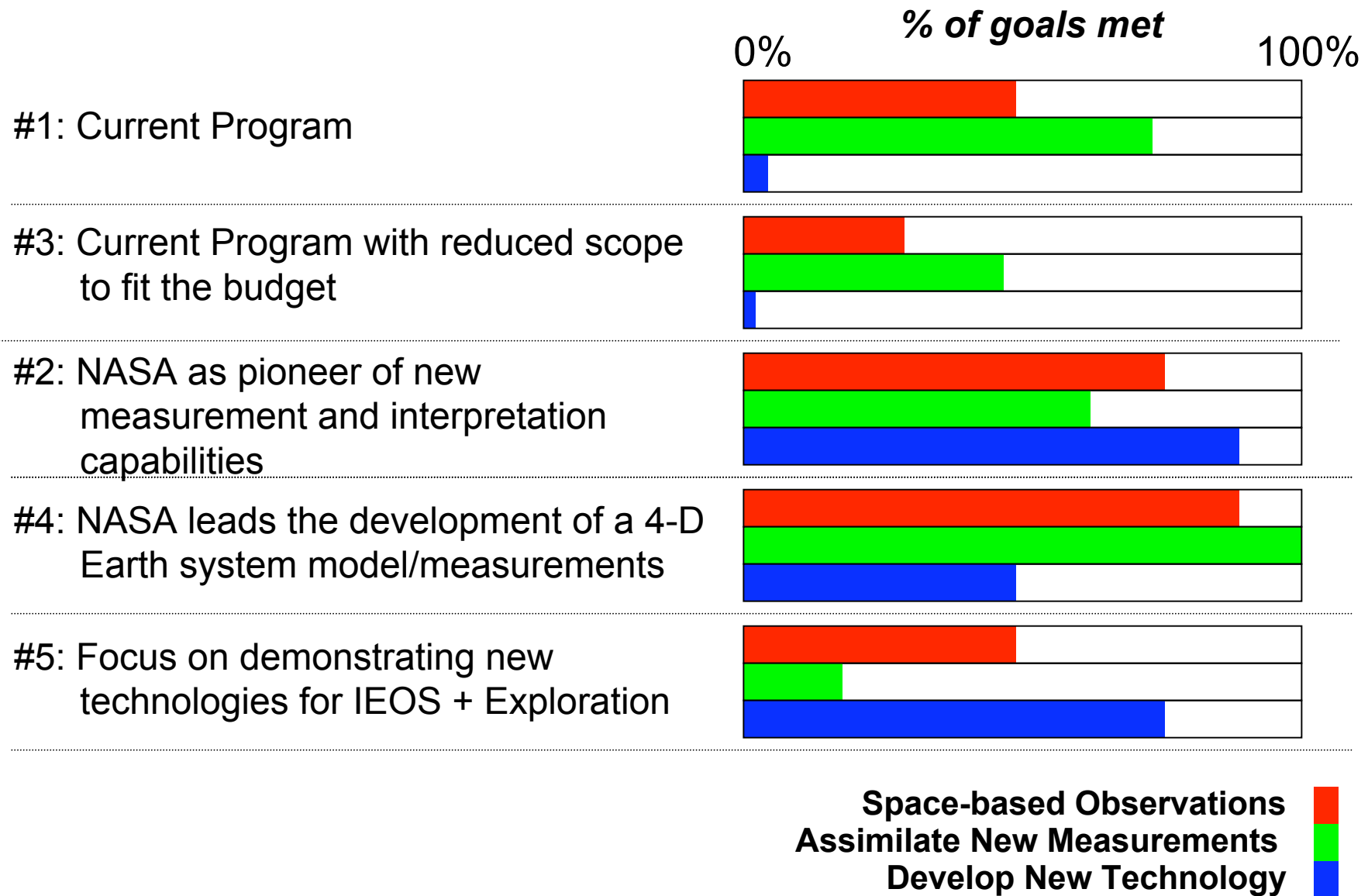


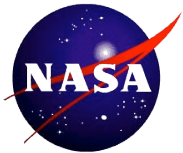
Roadmap #9 - Alternatives

- Scenarios:
 1. Current Program
 2. Current Program with reduced scope to fit the budget
 3. NASA as pioneer of new measurement and interpretation capabilities
 4. NASA leads the development of a 4-D Earth system model/measurement capability
 5. Focus on demonstrating new technologies for IEOS and Exploration

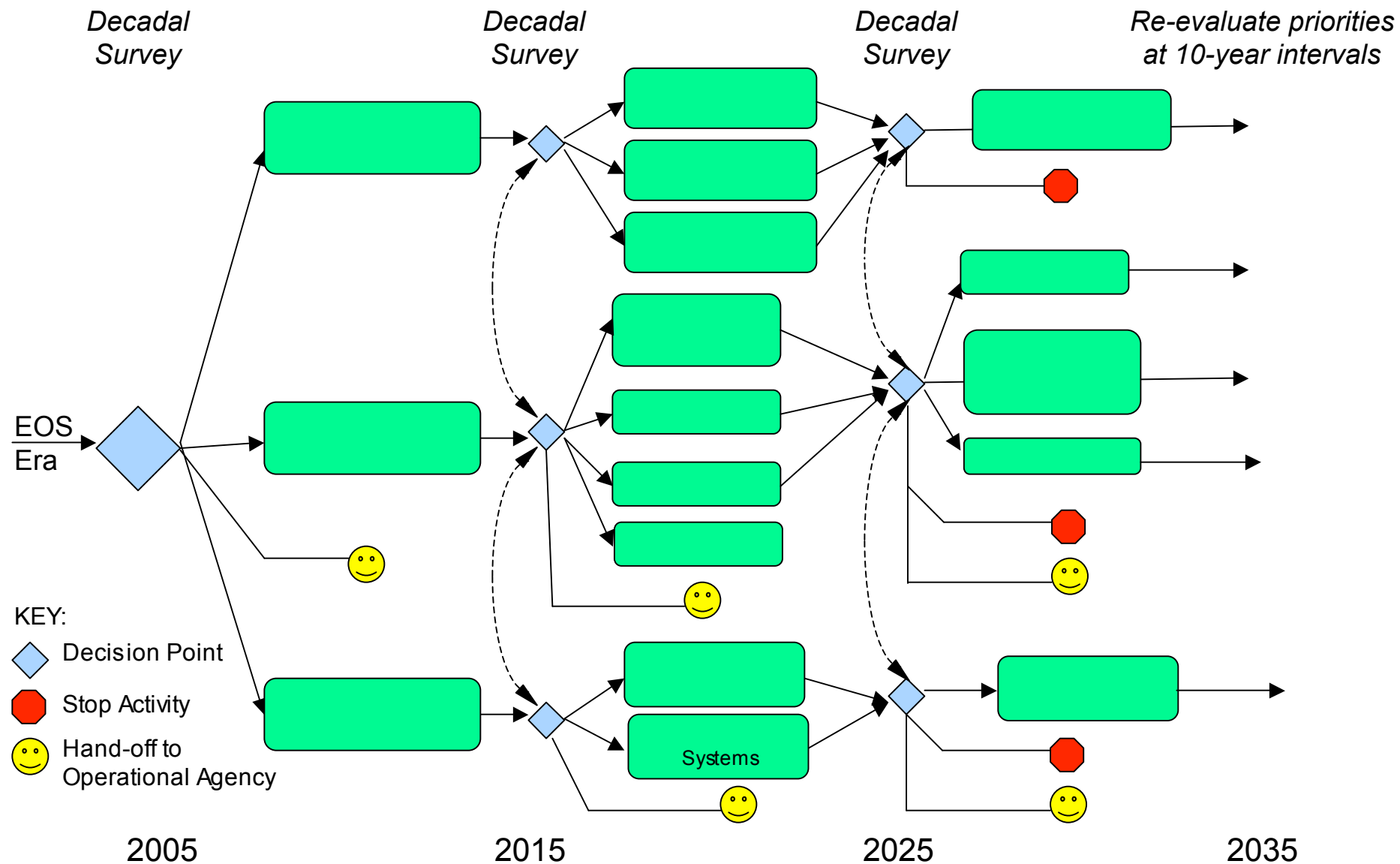


Scenarios





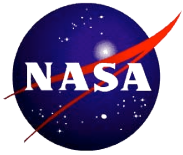
Example Scenario Timeline





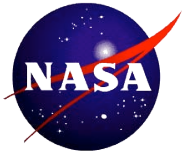
Prioritization

- A potential prioritization scheme for Earth Observation:
 1. *Space-based Observations*
 - i. Will the proposed investigation provide new measurements of the Earth system or a significant (i.e. order-of-magnitude) improvement over existing measurements
 - ii. Will the proposed investigation result in discoveries which will enable the agency's exploration vision to be achieved?
 - iii. Will the proposed investigation result in discoveries which will stimulate public interest?
 2. *Assimilate new measurements*
 - i. Does the proposed investigation result in new measurements that have been identified as required inputs to Earth system models?
 - ii. Will the proposed investigation result in discoveries which will lead to an understanding of the effects and underlying causes of climate change?
 - iii. Will the proposed investigation result in a better understanding of biosphere signatures?
 3. *Demonstrate new technologies and capabilities, including those with the potential to improve future operational systems*
 - i. Will the proposed investigation result in an advance in technology readiness level?
 - ii. Is the performance capability to be demonstrated identified as a goal or requirement by an operational agency?
 - iii. Has the proposed investigation identified a logical path to hand off the capability developed to an operational agency?



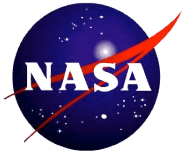
◆ Decision Points

- 2015:
 - Exploration activities shift from robotic missions to human missions
 - Discovery of life on another body in the solar system
 - Discovery of an Earth-sized planet around a nearby star
 - Heightened public concern over the effects of climate change on air quality, fresh water availability, or biodiversity
 - The effects of clouds and surface hydrologic processes on Earth's climate are understood
 - The response of ecosystems, land cover and biogeochemical cycles to and their effects on environmental change are traceable
 - The linkages between climate variations and global ocean circulation are resolved
 - The connections between atmospheric trace constituents and global environmental change are understood
 - The effects of natural variability and human-induced change on sea level can be estimated
 - Heightened public concern over natural disasters
 - Responsibility for Natural hazards or Climate Change assigned to one agency in the US



◆ Decision Points

- 2025:
 - Exploration activities shift from manned Lunar missions to Mars missions
 - US initiative to colonize Mars “by the end of this century”
 - IEOS decision to migrate from LEO observations to MEO to increase coverage, reduce cost
 - Weather forecasting capability is significantly improved
 - Climate variability and change are understood
 - The impact of changes in atmospheric composition on ozone, climate and global air quality are readily predictable
 - Future changes to carbon cycle dynamics and ecosystems are easily projected
 - Changes in water cycle dynamics can be forecast
 - We can predict and mitigate natural hazards through our knowledge of Earth surface change
 - Society starts to plan major population shifts to zones of greater habitability
 - Society requests solutions for climate control



Missions

- **A methodology to populate the ‘missions’ timeline:**
 - Identify a set of scenarios to examine
 - Select figures of merit (FOM)
 - Construct a prioritization scheme for each scenario based on the FOM
 - Examine the mission set through the prism of each scenario and prioritization scheme
 - Decide on the relative importance to attach to each of the three main objectives (i.e. select a scenario)



Next Steps



- Agree on content for the sections in **red**:
 1. Introduction
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- Content for sections in **blue** should follow easily once the **red** sections have been populated